



## Starch solids percentage: what do you mean by that?

***There are several ways to calculate solids. Be aware of what you're measuring, and be consistent.***

By Rex Woodville-Price

With the recent increases in corn prices and corn future contracts, it is unlikely we will see a significant drop in industrial cornstarch prices any time soon. This makes the task of managing starch consumption in the box plant, one that will have a real impact on the bottom line. Optimal use of adhesive is a balance of finding the application rate that affords the best bond with the minimum amount of delamination. Applying too much adhesive is not only wasteful but it also slows the machine down; not enough adhesive will lower pin adhesion values and give poor wet strength performance.

An important part of this strategy is assuring that your current adhesive formula is optimized and has adequate solids contents for your product mix. This has become even more relevant with the papers available in the market today. But what do we really mean when we refer to the solids contents of our adhesive formula? Where does this number come from? At first glance it seems pretty straightforward; it is the amount of solids in the adhesive, expressed as a percentage. However, there are several ways to calculate the solids contents of an adhesive formula and it is important to understand how that number is derived so that one can usefully compare one formula to another.

We will look at the most common ways used to calculate commercial solids. When we say commercial solids we mean that we use the actual weight of the starch. This is simple enough, if we use a hundred pound bag of cornstarch we will use 100 pounds as its weight. (Actually, there are only about 88 pounds of starch in that sack because cornstarch typically has about 12 percent moisture content, but we'll

look at it in more depth in the sidebar on oven dry solids.)

The three most frequently used methods for calculating commercial solids are the following.

### 1. Starch vs. water

Using this method, we divide the weight of the starch by the weight of the starch and the water. As the name implies, here we are only considering the weight of the starch and the water, nothing else; we ignore the weight of the other ingredients.

### 2. Starch vs. batch weight

When we use this method to calculate the solids contents, we divide the weight of the starch by the weight of the entire batch. This is perhaps a more conventional way to calculate starch solids since it actually compares the weight of the starch against the weight of the whole batch. This tends to give us a clearer picture when changing starch solids, since this process usually involves adding or removing pearl starch from the secondary portion of the batch and generally does not change the other ingredients in the batch.

### 3. All solids vs. batch weight

This last method obtains the solids content percentage by dividing the weight of all the solids (starch, borax, caustic and any additives) by the weight of the entire batch. It gives a result that is comparable in content to that given by the oven dry technique because it too includes the weight contribution of all the solids in the batch. There is however a large difference in the actual number since this one includes all the moisture content of the starch.

### Use the method you prefer, but always do it the same way

Currently there is no industry-wide standard for which method to use. There isn't even much in the industry literature describing how to do these calculations. Technically, no one method is any more accurate or really

#### FORMULA EXAMPLE

Primary water	184 gal
Primary cornstarch	188 lbs
Caustic soda (dry)	33 lbs
Secondary water	350 gal
Borax (5 mol)	22 lbs
Secondary cornstarch	1,143 lbs
Additive	85 lbs

#### SOLIDS PERCENTAGE COMPARISON

Starch vs. water method	23%
Starch vs. batch weight method	22%
All solids vs. batch weight method	25%
Oven dry (at 12% moisture)	21%

## Measuring starch solids, continued

has any advantage over the others and thus it often becomes a matter of preference as to which one is chosen. We must, however, understand that they do not all paint the same picture. It is therefore important to ensure the same method is used when comparing formulas. As we can see from the attached table, the percent solids number for the sample formula can vary significantly depending on which method is used to calculate it.

### Consider the condensate

Most starch kitchen employ steam to heat the water used in the batch. When we heat water using steam, that steam condenses and becomes water again, so the process invariably adds extra water. The colder the incoming water is, the more condensate that will be added. Most modern starch kitchens use load cells to weigh the ingredients, so they are usually programmed to account for this water and will deliver the correct amount. If the step asks for 100 pounds of water at 105 degrees, it may only put in 80 pounds, heat it and then add more water to complete the required 100 pounds. This is typically referred to as *finish water*.

With older primary/secondary mixers which are not mounted on load cells, we need to be aware of this extra water being added to the batch. The best way to account for it is to measure the volume of the water before and after the heating step.

So next time someone tells you the solids content of a formula, ask them how it was derived, it will show your deeper understanding of the subject and will assure that you are comparing apples to apples.



### Refractometer and dissolved solids

While on the subject of solids, it is pertinent to mention the refractometer, an instrument you will often see our technicians using on your adhesive. A refractometer reads the amount of dissolved solids in an adhesive and not the total solids content. The only solids in the adhesive are those that were cooked in the primary portion of the batch, all the secondary starch is still raw and will not be read by the refractometer. This is why a typical swell formula will show very low dissolved solids since most of its solids are still raw. Our technicians measure the dissolved solids because they are very important in the initial bond (especially of heavyweight papers) due to the fact that this is the only starch that is able to penetrate between the paper fibers; the raw granules are too large.



An infrared (IR) moisture meter, common in box plants to check paper and combined board moisture, can also be used. Just set a weigh dish in the meter and zero the scale, add 3 grams to 5 grams of adhesive, close the lid and run the test. This type of meter takes only 8 minutes to 12 minutes to run.

## Oven dried solids

The most common way to measure adhesive solids in the laboratory is to dry the adhesive sample in an oven. The weight remaining after all the water is driven off, is the solids contents of the adhesive. This process is usually done with an IR oven that has a built-in scale, so it automatically weighs, records and even calculates the percent solids.

Oven drying gives us a number that includes all of the solids in the batch and can be calculated arithmetically

using the *all solids vs. batch weight* method if we subtract the weight of the moisture in the starch (typically between 10 percent to 12 percent). Be aware that oven drying will often produce a value even lower than the calculated one because several of the other solids (e.g., borax and dry caustic) are hygroscopic and contain some moisture, which is also driven off. Several additives (resin in particular) will also volatilize, further lowering the number.

# Dry pounds per gallon calculation: why accuracy matters

by John Kohl

**W**ith the cost of pearl starch still at an all time high, and the pressure on box plants to control costs, it's never been more important to account for starch consumption accurately. Small calculation errors will become large variances in starch consumption calculations, job costing, and inventory management.

The dry pounds per gallon number usually comes from the starch supplier who set up the adhesive formula being used. It is not always accurate and may not have been updated in accounting. When a plant consumes 3 million to 6 million pounds of pearl starch per year an error of only 0.03 pounds at \$0.25 per pound will add up to a discrepancy of \$22,500 to \$45,000 per year.

(See table)

Dry pounds per gallon are calculated with starch only divided by the total batch volume:

$$\text{Dry lbs/gal} = 775 \div 315 = 2.46 \text{ lbs/gal}$$

If the adhesive formula is changed where the solids are lowered from 27.0 percent to 25.0 percent, the dry pounds per gallon and subsequent consumption calculation will be lower:

$$2.46 - 2.23 = 0.23 \text{ lbs per gallon}$$

When consumption is calculated based on the starch batches made and the dry pounds per gallon factor is not changed in the calculation, the saving of \$0.05 per MSF goes unaccounted for.

## Typical 315 gallon batch in an automatic mixer

Primary water	834 lbs	834 lbs
Primary starch	95 lbs	95 lbs
Primary caustic (dry wt)	16 lbs	16 lbs
Borax (5 mol)	10 lbs	10 lbs
Secondary water	1230 lbs	1250 lbs
Secondary starch	680 lbs	600 lbs
Total weight	2865 lbs	2805 lbs
Batch volume	315 gal	311 gal
Solids (starch only)	27.0 %	24.8 %
Dry lbs per gal	2.46	2.23

For a box plant producing 80,000 MSF per month with an application rate of 2.5 lbs/MSF, this would be a reduction of 9.3 percent, or 0.23 lbs/gallon.

Remember this also applies when the formula solids are increased; the cost per square foot of combined board will go up.



## Thirteen recognized for service longevity

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Not in photograph:  
Augusto Cavallini (21 years)  
and Pete Snyder (26 years).

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